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(54) **Impulse protection device**

(57) The device has a Ne or Ar filled chamber 7 through which independent conductors 1—6 pass, and includes an insulating plate 10, which has a shaped conductive coating 14, e.g. of molybdenum manganese, spaced from the conductors and so arranged that a plurality of spark-gaps 16 are provided between the conductors 1—6 and the respective adjacent portions 15 of the coating 14. When one spark-gap breaks down, all the remaining spark-gaps also breakdown. Thus if a very large impulse appears on the conductors e.g. due to nearby lightning or nuclear explosion, the first spark-gap to breakdown, e.g. connected to non-sensitive equipment, triggers the remaining spark-gaps thereby protecting any sensitive equipment connected to the other conductors. Areas of plate 10 not provided with conductive coating 14 may have an insulating film 18 of barium titanate to enhance breakdown of the gaps.

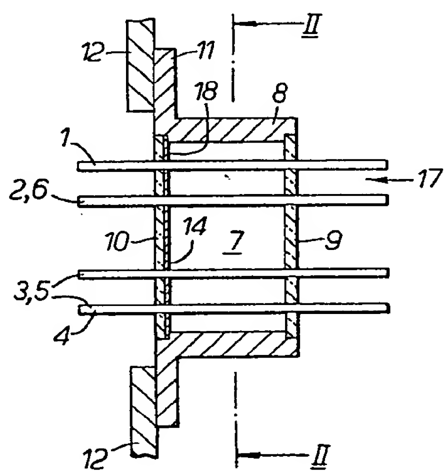

FIG. 1.

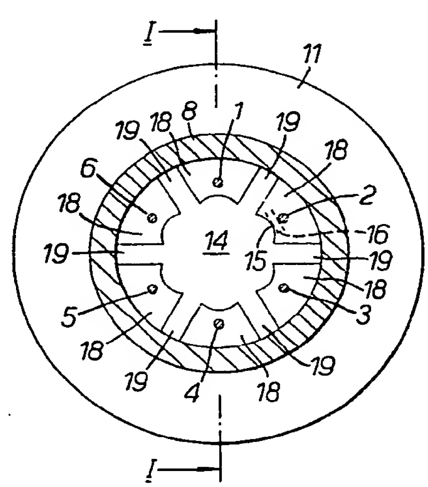

FIG. 2.

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The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.
This print takes account of replacement documents later filed to enable the application to comply with the formal requirements of the Patents Rules 1978.

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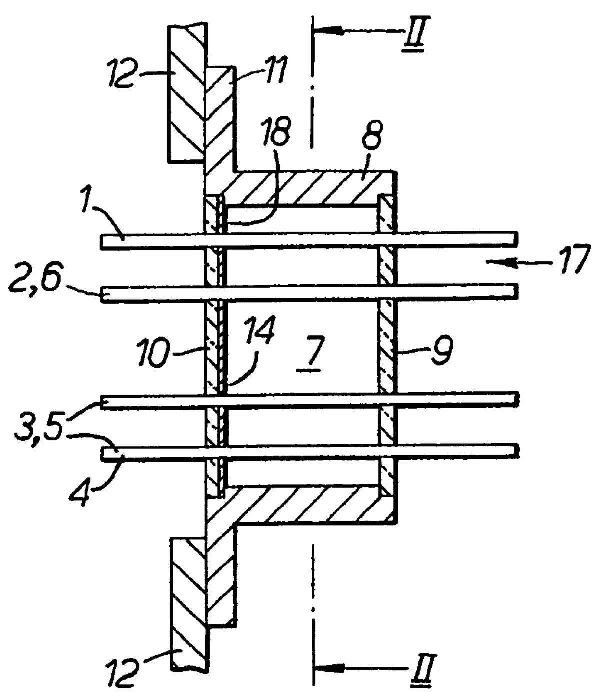

FIG. 1.

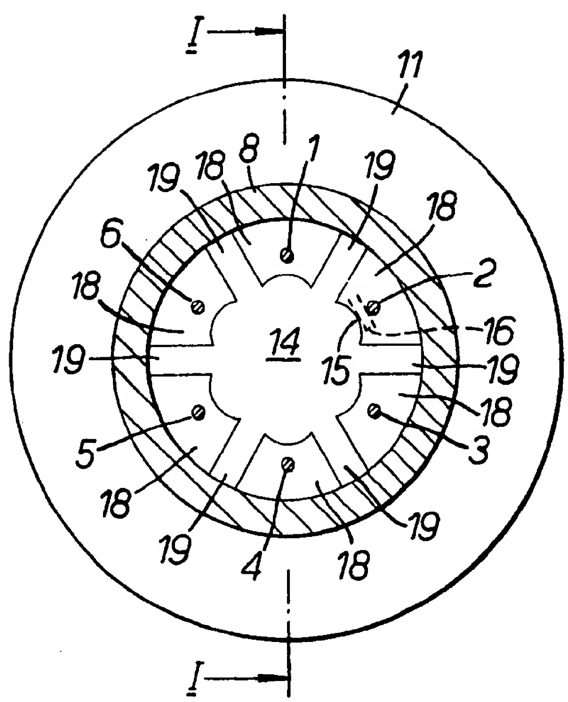

FIG. 2.

SPECIFICATION
An impulse protection device

This invention relates to impulse protection devices of the kind which include a spark gap across which current will flow when the electric potential on the gap exceeds a threshold value. Such a gap is situated within a sealed chamber, usually containing a gas selected to give the required voltage breakdown and current conduction characteristics. In use, one side of the spark gap is connected to an electrical conductor, so that when a high value voltage impulse appears on the conductor, it is diverted via the spark gap, usually to earth, thereby protecting any sensitive equipment which is also connected to the conductor. Conventional impulse protection devices which are cumbersome, and do not lend themselves to the provision of a number of spark gaps positioned in proximity to each other, which are arranged so as to protect a corresponding number of respective conductors.

This invention seeks to provide an improved impulse protection device having a number of spark gaps, each of which can influence the voltage breakdown value of the others.

According to this invention, an impulse protection device comprises a sealed chamber into which a plurality of electrically separate conductors are arranged to penetrate; an insulating plate composed of a high dielectric material carrying a shaped electrically conductive coating on one surface thereof, which coating is positioned so as to be in the interior of the chamber; the respective conductors being arranged to pass through apertures in the plate so as to be in contact therewith, and the coating being spaced apart from the conductor, and wherein the conductors and respective portions of the coating adjacent thereto, constitute a plurality of spark gaps.

The conductive coating constitutes one common electrode for all of the spark gaps, which can therefore be placed in very close proximity to each other. The invention is particularly suitable to protect conductors which pass right through the sealed chamber, so that the chamber itself can constitute part of a bulkhead, or wall, to one side of which the equipment which is to be protected can be located. The profile of the conductive coating can be so shaped as to provide spark gaps of differing dimensions, so that the different conductors can be protected against excess voltages of different magnitudes. Since the spark gaps are all located within a common chamber, the breakdown of any one spark gap is likely to initiate breakdown of all gaps. The invention is therefore particularly suitable to provid protection against electromagnetic pulses which are induced into all of the conductors almost simultaneously by a large external electromagnetic field. Such a field can be caused by lightning discharges or by a nuclear detonation. Although the spark gaps can commence conduction very rapidly, there is inevitably a very short, but finite, delay which in some circumstances may be insufficient to protect very sensitive equipment. The protection device ensures that as soon as the first spark gap has broken down (i.e. current has commenced to flow across it), all of the remaining spark gaps within the chamber follow very rapidly into conduction before excessive voltages are established across them.

The invention is further described by way of example with reference to the accompanying drawing, in which

Figure 1 shows a sectional elevation view of an impulse protection device, and

Figure 2 shows a sectional plan view of the same device.

Referring to the drawings, a number of electrically separate elongate electrical conductors 1 to 6 pass through a sealed chamber 7, which is constituted by a metal body 8 of hollow cylindrical shape and two insulating end plates 9 and 10. Each end plate 9 and 10 is composed of a high dielectric material to which the conductors 1 to 6 can be brazed, so as to form a gas tight seal. Conveniently, the material is a ceramic having a high alumina content as such a material has high dielectric properties. It is also an excellent electrical insulator and it is receptive to brazing processes so that it can be readily bonded to the body 8. The body 8 is provided with a large annular flange 11 by means of which the device can be attached to a bulkhead 12, which could conveniently form part of a closed housing positioned to the left of the bulkhead in Figure 1.

In practice, it is expected that a housing to the left hand side of the bulkhead 12 (as viewed in Figure 1) will be connected to sensitive electronic equipment or other devices which must be protected against the adverse effect of excessively high voltage pulses. Electromagnetic impulses can easily be induced on to elongate conductors as a result of lightning discharge in the atmosphere or the detonation of a nuclear device. In such a case, a burst of an intensely strong electromagnetic field sweeps across the conductors and induces into them a voltage impulse which can have a very high magnitude—of the order of several thousand volts. Such a voltage pulse can easily damage sensitive equipment and the purpose of the protection device is to divert the energy of such a pulse to a reference potential, usually earth, via a very low impedance path.

To enable the protection device to divert the electromagnetic energy, each conductor 1 to 6 has associated with it a spark gap of precisely controlled dimensions. The size of the spark gap determines the voltage at which breakdown occurs through a gas which is contain d with the sealed chamber 7. The nature of the gas and its pressure also affects the breakdown voltage quite significantly, and thus for given spark gap sizes the operating potential can be adjusted by altering the composition of the gas and its pressure.

The interior surface of the insulating plate 10 carri s a coating 14 of a material which has a very good electrical conductivity. Conveniently, the conductor material is applied in solution to one surface of the ceramic, and one material which can be readily applied in this way is molybdenum manganese in the form of a fine powder. The area of the plate 10 which is coated in this way is indicated most clearly in Figure 2 and it will be seen that no such coating is applied in the immediate vicinity of each conductor and that the closest point of the material to each conductor is constituted by a curved extension thereof, such as at 15. After the molybdenum manganese has been applied to the insulating plate, it is sintered at about 1100°C so that the material forms a firm molecular bond with the ceramic material itself. In order to produce a more robust coating having an improved electrical conductivity, the molybdenum manganese can be plated with zinc or copper to give the required overall thickness. The remaining interior surface of the plate 10, (the surface regions not having a coating 14) is covered with a thin layer 18 of barium titanate. This material acts to dope the surface of the ceramic material, and gives amplification of the electric field across the spark gap.

The device as shown in the drawing is then assembled with the two insulating plates 9 and 10 being brazed to the body 8, and the six conductors being inserted through the respective apertures in the plates 9 and 10 and brazed in position. A suitable gas is then induced into the interior of the chamber 7 at a selected pressure. Typically, the gas will be neon, or a mixture of neon and argon, or possibly nitrogen at pressures which are less than one atmosphere. Typically, the width of the spark gap 16 is of the order of one millimetre. In use the flange 11 is connected to earth so as to provide a very low impedance path to the coating 14.

In operation, when a high voltage impulse appears at any one of the conductors 1 to 6 and approaches the device in the direction of the arrow 17, the gas adjacent to the appropriate spark gap will be ionised and a plasma will form. The gap breaks down and conducts electricity to the coating 14. Extension arms 19 of the coating connect with the body 8 to constitute a low impedance discharge path. Breakdown of the spark gap is enhanced by the high dielectric properties of the ceramic and the layer 18 of barium titanate, which constrains the electric field to be at its most intense across the gap.

The invention is particularly suitable to provide protection in those cases where high impulses are likely to appear on all conductors almost simultan ously. In practice, one of the spark gaps will inevitably be the first to breakdown and will cause ionisation of the gas within the chamber 7, thereby breaking down all of the remaining spark gaps even though the voltages on them may not have risen to their nominal breakdown threshold voltage. Thus even if the first spark gap does not breakdown sufficiently rapidly so as to fully protect sensitive equipment connected to it, nevertheless equipment connected to all of the other conductors will be protected since the appropriate spark gaps will conduct before the breakdown voltage area reached. Since it is generally desired to provide different protection levels for the different conductors, it is merely necessary to shape the coating 14, so as to alter the respective sizes of the spark gaps 16. It may, therefore, be desirable in some instances to arrange that the smallest spark gap associated with it is not connected to sensitive equipment. In general, therefore, this spark gap will breakdown first and protect all of the other conductors in an extremely rapid fashion.

Claims

1. An impulse protection device including a sealed chamber into which a plurality of electrically separate conductors are arranged to penetrate; an insulating plate composed of a high dielectric material carrying a shaped electrically conductive coating on one surface thereof, which coating is positioned so as to be in the interior of the chamber; the respective conductors being arranged to pass through apertures in the plate so as to be in contact therewith, and the coating being spaced apart from the conductor and wherein the conductors and respective adjacent portions of the coating adjacent thereto constitutes a plurality of spark gaps.

2. An impulse protection device as claimed in claim 1 and wherein those interior surfaces of said insulating plate which are free of said coating, carry a surface dopant arranged to locally enhance the electric field strength.

3. An impulse protection device as claimed in claim 2 and wherein the surface dopant is barium titanate.

4. An impulse protection device as claimed in any of the preceding claims and wherein said insulating plate constitutes part of the wall of said sealed chamber.

5. An impulse protection device as claimed in claim 4 and wherein a further insulating plate is provided to constitute a further part of said wall, the further insulating plate being substantially parallel to the first plate, and each conductor being arranged so as to pass through both plates.

6. An impulse protection device as claimed in any of the preceding claims and wherein said coating is electrically connected to a conductive portion of said housing which acts as a discharge path when a spark gap conducts.

7. An impulse protection device substantially as illustrated in and described with reference to the accompanying drawing.

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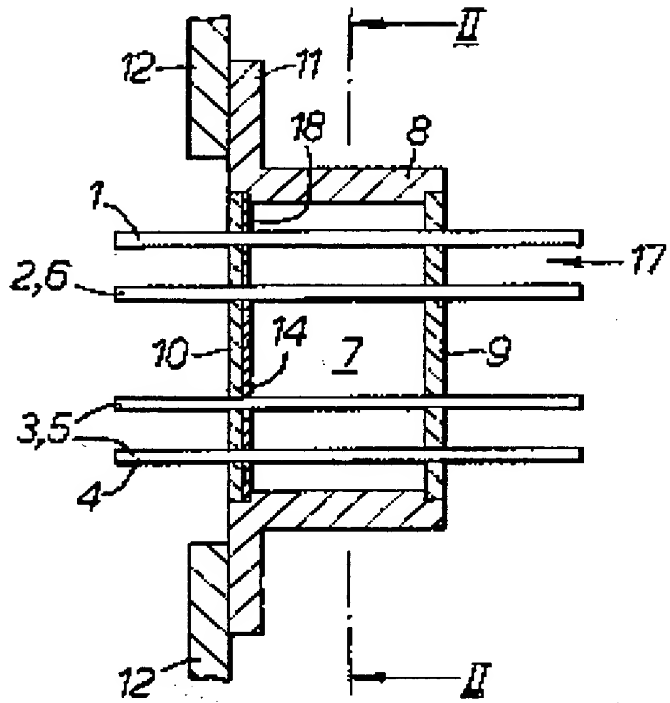

FIG. 1.

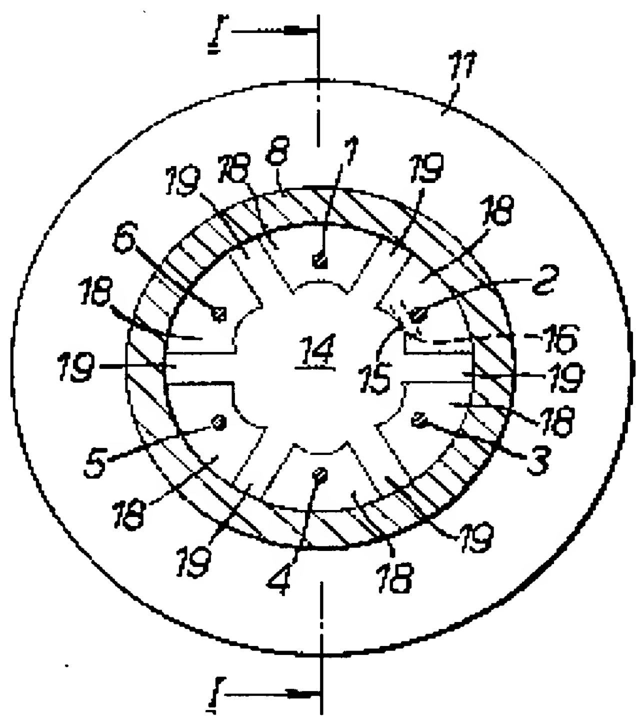

FIG. 2.